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MAKING LOW-MOISTURE SILAGE IN REGULAR TOWER SILOS

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The efficiency of conservation of hay crop nutrients for winter feeding is affected by many variables. One of the most important variables is that of weather during harvest. Studies at Beltsville, Md., have shown that when alfalfa is harvested as field-cured hay, losses may run from 20 to as high as 40 percent, depending upon weather conditions. Sometimes the entire crop may be lost. When the same crop is harvested as wilted silage, a loss of only 15 percent of the nutrients takes place before the forage reaches the cow. With direct-cut silages losses may frequently be 20 to 25 percent. Results of these studies have indicated that harvesting of hay crops as silage is one of the more efficient methods for conserving the nutrients of such crops. This is especially true of the first cutting because inclement weather very often intervenes during harvest.

According to present recommendations, grass silage is usually harvested by one of two methods: (1) as direct-cut high-moisture silage with use of some type of preservative; (2) wilting the crop in the field until its moisture content has decreased to 65 or 70 percent and then chopping and blowing the silage into the silo without adding a preservative.

While it has been found that making the hay crop into silage is a good method of preserving forage dry matter, such silages are consumed by dairy cattle in somewhat limited quantities. This low rate of silage consumption as compared to the same crop made into high quality hay is a frequent criticism. Unless extra grain is fed with the silage, milk production and body weight gains will suffer. An example of the comparative consumption of silage and hay and its effect on production may be seen in Table 1.

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TABLE 1--Comparison of consumption, milk production, and liveweight gains of cows fed direct-cut silage or hay.

Item	Direct-cut Silage	Hay
Dry matter in forage fed....................pct.	24	89
Forage dry matter consumed...........lb./cow/day	17.8	24.6
Concentrate dry matter consumed......lb./cow/day	6.5	6.3
Milk production FCM[1/]................lb./cow/day	24.6	27.1
Body weight gain or loss.............lb./cow/day	-0.8	+0.6

1/ 4 percent fat corrected milk.

Some silages are much more acceptable than others and it has generally been observed that the more the forage is wilted before ensiling the greater will be its acceptability. The reason for the poor acceptability of silage is not clear at the present time but is probably not due to the water content of the silage in itself at the time of feeding since artificially drying the silage to the same moisture content as hay does not increase intake by cattle. It is more likely that the acceptability is affected by the water content of the forage at the time it is placed in the silo. The amount of water in the forage at the time it is ensiled affects not only the moisture content of the resulting silage, but it also affects the type of fermentation and quality of the silage. Thus, while a very definite relationship exists between the moisture content of the silage and its acceptability by dairy cattle, the chemical changes that have taken place determine acceptability, rather than the amount of water at the time it is consumed.

Information obtained at Beltsville has shown that the acceptability of silage is improved if moisture content of the ensiled forage is reduced to 50 percent or lower. However, if air is not very well excluded from forage of such low moisture content, it will mold, will heat, and have a reduced feeding value. Air can be sealed out with specially constructed gas-tight silos and the resulting low-moisture silage is commonly called haylage. Concrete weights are used to aid in sealing the low-moisture silage made in the Cremasco silos of Italy. However, if a convenient method of using regular tower silos for storage of low-moisture forage can be developed, its usefulness would be even further extended. Attempts to produce low-moisture silage in regular silos have been initiated and the progress of these experiments is now reported.

The first effort in this direction was made in 1958 when third cutting alfalfa was stored in a concrete stave silo. This silage contained 52 percent dry matter when fed and was consumed even better than heat-dried hay made from the same crop (26.5 and 24.2 lbs. of dry matter per cow per day, respectively).

Encouraged by these results the experiments were continued in 1960. First growth alfalfa was mowed, crushed, and harvested by two

methods. Part of the crop was baled as partially cured hay and barn-dried with heat. The other part was harvested with a field chopper at an average dry matter content of about 42 percent and stored in two 10' x 40' tile silos. Dry matter content of individual loads ranged from 65 to 23 percent. The silage in both silos was thoroughly distributed and tramped and sealed at the top surface with plastic caps weighted with unwilted forage. Additional precautions against air exposure were observed in silo #1. A load of unwilted forage was stored on top at the end of each day's filling to form a more dense plug against air infiltration. This was intended to protect the low-moisture forage during the night when filling was interrupted and also to limit air movement during the feeding period when the silo was opened. Plastic mesh screens were placed below and above these plugs to identify them when the silo was emptied. The doors of silo #1 were sealed with a rubber gasket material.

Both silos were filled in the 3-day period May 19-21, 1960. Temperatures were periodically observed at six points in each silo by means of thermocouples placed near the middle and on top of the low-moisture forage stored each of the 3 days. Each load of forage stored was weighed and a sample obtained for chemical analyses. Weights and daily samples were also obtained when the silage was fed out.

Silo #1 was fed out from November 11 to February 14, 1961, and silo #2 from February 14 to May 17, 1961. The feeding values of the heat-dried hay and low-moisture silage were compared during this period in feeding trials with dairy cows and heifers and in a digestion trial with sheep. The plugs of direct-cut silage were not utilized in these comparisons.

Feeding value of the forages for milking cows was measured in a 3-period, 90-day, double reversal feeding trial. Two groups of three milking cows were used and a 10-day adjustment period was allowed after each ration change. Silage or hay was fed <u>ad libitum</u> and one pound of a 16 percent crude protein grain ration was fed for each five pounds of 4 percent fat corrected milk produced. The feeding trial was designed as follows:

Period	Group A Ration	Group B Ration
1	Silage	Hay
2	Hay	Silage
3	Silage	Hay

The value of the two forages for heifers was measured in a continuous 90-day trial with five Holstein heifers fed <u>ad libitum</u> on silage or hay as the sole ration. Heifers averaged 17 months old at the start of the trial and the groups were balanced on the basis of consumption of a standard ration previous to the trial.

The digestibility of forage dry matter and energy was measured with six sheep in a total collection, single cross-over trial.

Results

In measuring the efficiency of the low-moisture silage system, major emphasis was given to prevention of spoilage and high temperatures and recovery of dry matter for feeding. The recovery of dry matter by layers, as well as the weight and dry matter content at the time of storage, is presented in Table 2. The top layer in each silo suffered the greatest loss in spite of the plastic seal. More than 90 percent of the dry matter in the other layers was recovered for feeding. A small amount of spoilage occurred in the lower part of silo #2. This is believed to have occurred in the only silage that was left on the wagon overnight before storage.

The chemical characteristics of the low-moisture portions of each silo are presented in Table 3. These values are generally typical of good haylages, which have been made in gastight silos. The low levels of butyric and acetic acid and ammoniacal nitrogen indicate good quality and a mild pleasant aroma.

TABLE 2--Efficiency of dry matter recovery.

Layer		Forage stored			Dry matter recovery		
		Weight	Dry matter		Feed	Spoilage	Lost
		Lb.	Pct.	Lb.	Pct.	Pct.	Pct.
				Silo #1			
Top	6	11,510	23.7	2,726	45.8	12.1	42.1
	5	16,970	40.3	6,843	96.0	.5	3.5
	4	3,240	25.0	810	90.7	----	9.3
	3	23,000	48.8	11,226	96.1	----	3.9
	2	5,290	25.4	1,344	99.0	----	1.0
Bottom	1	7,620	63.7	4,852	96.5	----	3.5
Total		67,630	41.1	27,801	91.2	1.3	7.5
				Silo #2			
Top	3	13,670	25.4	3,479	88.5	3.1	8.4
	2	12,490	43.4	5,422	98.1	---	1.9
Bottom	1	32,060	48.3	20,311	95.9	3.8	0.3
Total		68,220	42.8	29,212	95.4	3.0	1.6

TABLE 3--Average chemical quality of low-moisture silages

Silo	Dry matter	pH	Ammoniacal nitrogen[1/] as protein	Organic acids[1/]			
				Butyric	Prop.	Acetic	Lactic
	Pct.		Pct.	Pct.	Pct.	Pct.	Pct.
1	42.0	4.8	2.3	0.7	0.2	2.9	4.7
2	43.2	4.6	2.0	.1	.1	2.4	5.2

1/ Dry-matter basis.

All of the temperatures observed were within the normal range expected in well sealed haylage. Maximum temperatures were 108° and 112° for silos #1 and #2, respectively. Average temperature for the May 21 to October 11 period were 92° and 93°, respectively. The absence of prolonged high temperatures indicated that very little air leaked into the silage.

Results of the feeding trials with milking cows and digestibility determinations with sheep are presented in Table 4. No significant differences in feeding values of hay and silage were detected as measured by dry matter intake, milk production or liveweight changes for milking cows. The digestibility of the hay dry matter was lower than for the silage.

Results of the heifer growth trial are presented in Table 5. Liveweight gains and dry matter intakes were not significantly affected by feeding hay or low-moisture silage as the sole ration. All animals had received a 3-lb./day grain supplement prior to the experiment and were in good condition at the beginning of the trial. These facts may be related to the rather slow gains of both groups.

Dry-matter content of silage from silo #1 varied considerably because of the plugs of high-moisture forage located at three levels in the silo. Silage from the plugs was not fed experimentally, but the movement of seepage from the high-moisture forage increased the moisture content of wilted silage below the plugs. Heifers consumed less dry matter when moisture content of the silage increased. A highly significant positive correlation ($r=0.86$) between dry-matter consumption per hundred weight and percent dry matter in the silage by 5-day periods existed. The highly significant regression of dry matter consumption per hundred weight on percent dry matter in silage was $b=.030$.

TABLE 4--Results of feeding trial with milking cows.

Period	Dry matter consumed per day			4 percent fat corrected milk	Daily liveweight gain	Average liveweight	DDM[1]
	Forage	Grain	Total				
					Lb.		Pct.
				Group A			
I Silage	22.0	4.7	26.7	24.1	0.20	906	
II Hay	20.7	4.3	25.0	22.6	.42	908	
III Silage	22.0	3.8	25.8	22.2	.47	910	
				Group B			
I Hay	25.1	4.9	30.0	22.2	0.55	1,108	
II Silage	26.6	3.8	30.4	21.7	.47	1,123	
III Hay	25.4	3.7	29.1	18.9	.50	1,131	
				Groups A and B			
Ration Ave.[2]							
Hay	23.0	4.4	27.4	22.5	0.45	1,013	56.8*
Silage	24.3	4.1	28.4	23.4	.41	1,015	63.0*

1/ Digestible dry matter determined with sheep.
2/ Adjusted for cow and period effects.
* Means significantly different at the 5-percent level of probability.

TABLE 5--Results of heifers growth trial
1960-61 90 days.

Item	Silage	Hay
Initial age.......................months	17	17
Liveweight:		
Initial..............................lb.	990	1,016
Final................................lb.	1,074	1,080
Gain.................................lb.	84	64
Gain per day.........................lb.	.93	.71
Dry-matter consumption:		
Per day..............................lb.	16.5	17.1
Per 100 lbs. liveweight..............lb.	1.62	1.64
Per lb. of gain......................lb.	17.7	24.1

Discussion

The use of conventional tower silos to store low-moisture silage is still in an experimental stage and should be approached with caution. However, results have been encouraging and the development of a dependable method appears distinctly possible at this point in the experiments. The high rates of preservation, relatively low temperatures, small amounts of spoilage, and feeding values equal to heat-dried hay have all been encouraging observations. The procedures used, however, should be simplified if possible. The similarity of results obtained in both silos indicates that the layers of unwilted forage and special door gaskets used in silo #1 were unnecessary although the doors must be tight. The necessity for thorough distribution and tramping will be studied in future experiments, because this is an uncomfortable and time consuming task.

It has come to our attention that despite insufficient information on the making of low-moisture silage in tower silos, farmers in some areas are attempting to use this method. When farmers desire to use the method, they should take the following precautions to promote rapid expulsion of the air from the silo and to exclude air after the silo has been filled:

- Use a tight silo with no cracks to admit air. The doors should be tight.

- Harvest the crop at an early stage of maturity, because at this stage forage is more pliable and will pack more easily than at a later stage when stems are stiff.

- Use a hay crusher, or hay conditioner, if available, to speed up wilting and reduce weather risks.

- Chop the crop as fine as possible so that it will pack well. The forage chopper should be set at 1/4" to 3/8" theoretical cut, the knives should be sharp, and the shear plate in good condition.

- Tramping and distributing the forage during filling aid in air exclusion and are, therefore, recommended. Mechanical distributors are helpful in this connection.

- To obtain air exclusion as quickly as possible, fill the silo rapidly.

- After the silo is filled, cap it with a layer of 18 to 24 inches of heavy material, such as direct-cut forage, and cover with a weighted plastic cap.

- Plan to feed the silage during the winter months.

It is absolutely essential that the air be excluded otherwise the silage will spoil. It should be kept in mind that it is more difficult to exclude the air in a low-moisture silage than in a high-moisture silage, because of the extra weighting from the water in the high-moisture silage. From a practical standpoint, farmers should proceed with caution in making silage with a moisture content below 65 percent. While such is possible, further experimental work needs to be conducted to learn more about the precautions necessary.

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